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EXPERIMENTS WITH OSTRICHES—XII.

HOW WEAKNESS AND DENSITY OF FLUE ARE PRODUCED.

By Professor J. E. DUERDEN, M.Sc., Ph.D., A.R.C.S., Rhodes University College, Grahamstown.

A clipping of spadonas recently received from Mr. F. R. Edwards, Wijers River, through the Editor of the *Agricultural Journal*, is of more than passing interest, in that it sheds much light upon the influence of nutrition and blood-pressure in the production of a weak or a dense flue. One of the feathers is shown in the accompanying photograph (Fig. 1), and differs from ordinary plumes in presenting an almost entire absence of barbules on the flue. The shaft and also the barbs coming from each side of it are normally developed, but only here and there can the merest traces of the barbules be recognised. Such a feather would be practically valueless for the usual purposes for which ostrich plumes are employed. While such extreme cases are rare, it is by no means unusual to find plumes in which the barbules are shorter than desirable, either over the entire feather or in places.

THE STRUCTURE AND NUTRITION OF A GROWING FEATHER.

To understand how such a plume as that shown has been produced requires a knowledge of the microscopic characters of the feather at its earliest stage of growth and also of its method of nutrition; but such a knowledge is well worth a little trouble to acquire from the explanation which it affords of many other problems connected with feather growth. If a thin cross section be made of a feather, while it is still soft and plastic in the lower part of the feather socket, the following parts will be recognised, and are diagrammatically shown in Fig. 2. The middle or interior of the feather is occupied by what is known as *pith* or *medulla*. This consists of a tissue of loose cells, among which is an extremely rich supply of blood-vessels—arteries, veins and capillaries. The blood is for the nourishment of the growing feather, and one easily realises how rich is the supply by the amount of bleeding or hæmorrhage which takes place when an unripe feather is clipped or punctured in any way; also when it is remembered that a wing feather grows at the rate of about a quarter of an inch a day, the need for such a copious supply of the nutrient blood is apparent. As the feather ripens the blood drains from it and the pith dries up, the space it occupied then becoming filled with air.

At the outer surface of the pith is a layer of cells which gives rise to the *horny sheath of the medulla*. This sheath is best seen in the older parts of the growing feather, and remains as a horny tube in the middle of the unopened feather after the pith dries up. As the feather expands it is,

however, preened away by the bird, but it can be seen enclosed in the middle of the ripe quill as a series of horny cones fitting over one another.

Next the medulla sheath is a series of cells arranged for the most part in wedge-shaped groups, as seen in transverse section. *It is from these cells that the entire feather is formed, the pith taking no part in producing the feather beyond serving to nourish the growing cells.* One of the groups of cells is much larger than the others, and this forms the shaft of the feather, while the numerous smaller groups of cells on each side give rise to the barbs and barbules of the flue. The barbs, however, are formed from the cells nearest the pith, that is, from those which are nearest the supply of nutrition, while the barbules are formed from the cells further away. No blood-vessels occur among these feather-forming cells, consequently they have to depend for their nutrition upon the fluid or plasma part of the

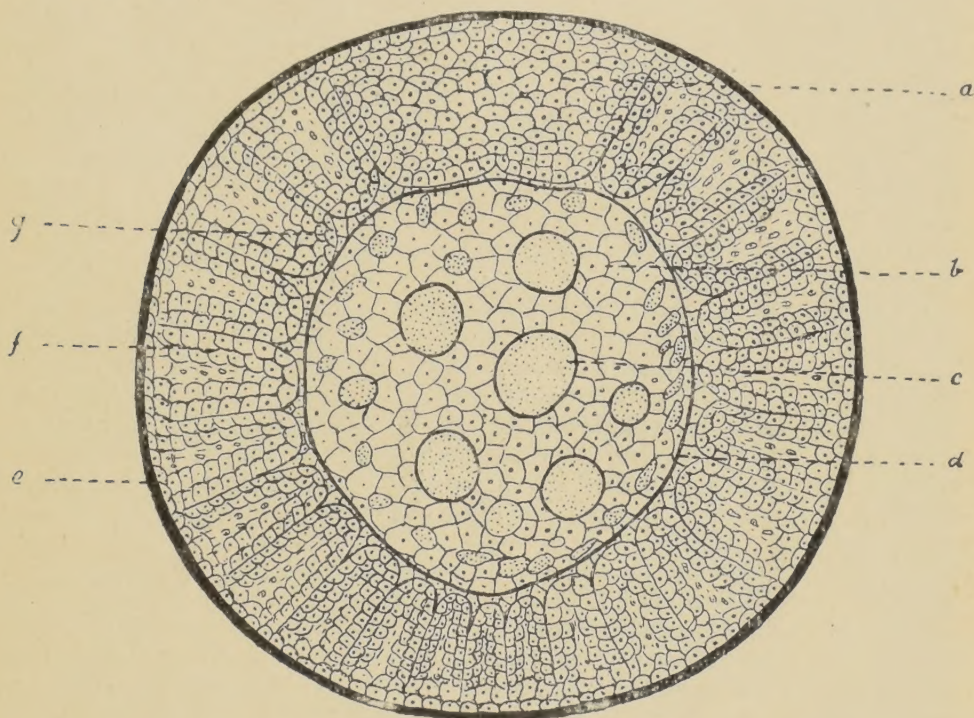


Fig. 2.—Transverse section of a feather at a very early stage of its development while soft and plastic within the socket (diagrammatic). In the middle is the pith or medulla containing the blood-vessels, through the walls of which the blood-plasma exudes to nourish the growing feather cells outside. Around the medulla is the medullary sheath, which remains after the blood has receded and the pith dried up. The cells outside the medullary sheath give rise to the feather and are without blood-vessels. The large group at the top of the figure will give rise to the shaft of the feather, and the wedge-shaped groups along each side to the flue, the barb-forming cells being inside and the barbule-forming cells nearer the outside. Surrounding the entire feather is the feather-sheath, which is preened away to allow the plume to open out as it ripens. *a*, shaft-forming cells; *b*, medulla or pith; *c*, blood-vessel; *d*, medullary sheath; *e*, feather sheath; *f*, barbule-forming cells; *g*, barb-forming cells.

blood which oozes out through the thin walls of the vessels in the pith; spaces, known as lymph-spaces, are found among the cells, and these are filled with the nutrient blood-plasma or lymph, which thereby bathes and nourishes the cells.

Outside the wedge-shaped groups of cells which form the flue and shaft is a layer of cells which gives rise to the *horny sheath of the feather*. This sheath completely covers the feather before it expands, but is preened away

by the bird as the feather ripens, and thus allows the flue inside to open out.

It is necessary to bear in mind that in the growing feather the blood and blood-vessels are confined to the pith; as already stated, *no blood-vessels are ever found among the cells which form the actual feather*. The cells forming the feather substance correspond with those which constitute the outer layer of our own skin (epidermis), and also give rise to the covering of hair; this outer skin in ourselves also is devoid of blood-vessels and nerves. The pith or medulla of the feather corresponds with our under-skin (dermis), which is well supplied with both nerves and blood-vessels. This being the case, it is manifest that the cells forming the feather must receive their nourishment by exudation of the fluid part of the blood through the thin walls of the vessels in the pith, and the blood-plasma must pass by diffusion among all the cells as far as the surface or feather-sheath. The cells nearest the pith will receive their nourishment first, and these are the cells which will ultimately give rise to the barbs, while those more distant, which give rise to the barbules and feather-sheath, will get their supply of nutritive fluid later. Should there be a deficiency in the nutrition of the growing feather the barbule-forming cells will suffer first, and the barb-forming cells later.

PRODUCTION OF FEATHERS WITHOUT BARBULES.

With the above facts before us as to the nature of the growing feather and its nutrition, we are in a position to understand the production of a feather devoid of barbules, such as that shown in Fig. 1. For some reason the amount of nutritive fluid exuding from the pith to the feather-forming cells around it has been sufficient to supply only the nearest cells, or those which give rise to the shafts and barbs; the fluid was absorbed before it reached the outer cells which give rise to the barbules, and therefore the barbules are absent or very imperfectly formed. The feather cells can only grow and multiply in proportion as they are supplied with nutritive materials from the blood, and either from lack of quantity or insufficient pressure, these materials have not penetrated to the barbule-forming cells.

Without an examination of the chick at the time the feathers were growing, or a knowledge of its food and surroundings, it is impossible to say what was the cause of such a defective nutrition of the feather; but whatever the cause, it must have been present all through the six months necessary for the growth of the spadon. The chick may have been in a very weak state of health from deficient food or some ailment, and hence the supply of blood to the growing feather was sufficient only for the cells forming the shaft and barbs; or, more probable, in its food was included some weed or grass, the action of which is to reduce the superficial blood-pressure, and therefore the pressure on the nutritive fluid was insufficient to force it to the cells furthest away from the central pith. This latter suggestion seems more likely from some recent experiences in Oudtshoorn described below.

Since receiving the feathers, however, inquiries have been made among other ostrich farmers as regards the frequency of occurrence of birds with barbules feathers, and some important facts have been elicited which call for a different interpretation. Mr. C. Gardner, of Harvest Vale, has sent a clipping of similar spadonas, and states that every feather on the bird, including the body-feathers, is of the same type. The bird is one of a large clutch of chicks, and none of the others are affected, although all the chicks have been treated alike. Mr. Lappan, near Grahamstown, also mentions an interesting case in which a bird from the chick stage onwards always gave a crop of feathers without barbules. None of the other birds in the



FIG. 1.

A spadona with an almost total absence of barbules. The feather consists of only shaft and barbs.

FIG. 3.

An Oudtshoorn feather with three defective areas due to the absence of barbules. The uppermost is the broadest and represents over a week's growth during which the bird was out of condition. The feather also shows a few shrinkage bars.

troop showed a similar deficiency, but each clipping of this particular bird was always devoid of barbules and all the body-feathers were of the same nature.

With these cases before one, and probably others will be forthcoming now the attention of ostrich farmers is drawn to the matter, it would appear that the production of barbuleless feathers is constitutional for the particular bird, not something dependent upon its food or surroundings, otherwise successive clippings would not show the same defect without any of the other birds in the troop being affected. Also the farmer cannot look forward to the bird ever recovering and growing an ordinary crop, though it need not influence any offspring. The defect is apparently inherent in the bird, something constitutional which interferes with the proper development of the barbule-forming cells. If physiological experiments could be carried out they might show that a low blood-pressure is characteristic of the birds through some malformation in its organs.

A NEW TYPE OF DEFECT IN CERTAIN FEATHERS FROM OUDTSHOORN.

A defect of a nature similar to the above was prevalent in some of the Oudtshoorn feathers in the early part of the present year, but in this case fortunately only a small part of the entire feather was affected. It created considerable interest at the time, being a new type of defect to most ostrich farmers. Specimens of the feathers were kindly forwarded me by Mr. A. Auret, of the Civil Commissioner's Office, and Mr. Wm. Taylor, Secretary of the Oudtshoorn Farmers' Association. One such plume is represented in the accompanying photograph (Fig. 3). It will be seen that at two places there is a defect in the flue extending as a broad band across the feather, and due to a complete or partial absence of the barbules, while further down the feather is a third narrow defective band. Each defective area passes gradually, not suddenly, into the normal portion of the feather, and except at the three bands the flue is of the well-known density, strength and richness so characteristic of Oudtshoorn feathers. In some birds all the feathers were defective in this way, while in others only old plumes suffered.

In this case it is evident that whatever caused the defect was only of short duration in its action, certainly lasting not more than a week or two. It can scarcely be imagined that the birds as a whole, kept under the stimulating Oudtshoorn conditions, had been reduced in their general nutritive condition for such a short period and then recovered almost as quickly. From what we know of the growth of the feather it seems more reasonable to suppose that the birds had eaten some plant or shrub which had the effect of reducing the superficial blood-pressure to such an extent that the barbule-forming cells were deprived of their nourishment for the time being. Inquiry among the Oudtshoorn farmers elicited the fact that all the growing feathers were affected at the same place, and that the trouble was not due to drought or poverty, the birds being in good condition all the time. The idea was expressed that the birds were poisoned by eating *Malva* (*Kissie Blaar*). Six birds in the camp died, and also two horses, as was supposed from eating the mallow. The birds were noticed to tremble all over the body after they ate the *Malva*.

From all one can gather, the trouble in Oudtshoorn commenced when some of the lucerne pastures at the end of the winter season had become infested with grass and weeds as a result of winter rains when the lucerne was not growing. Under such conditions it is easy to understand that some noxious or poisonous weed may have appeared in the pastures, or that the food may have disagreed with the birds in some way. Ordinarily the *Kissie Blaar* is supposed to be a harmless demulcent weed, and in places is

eaten by stock, but there seems to be some evidence in support of the contention of the Oudtshoorn farmers that at times it may be harmful. Some farmers will certainly not allow their horses to eat the *Malva*.* The whole subject is of much interest, and may become of importance should the defects recur from time to time; undoubtedly we have some poisonous weed which is capable of influencing the blood-pressure of a bird to such a degree that the barbules do not form on the growing feathers. A careful study on the spot would probably reveal the cause, and an investigation should be undertaken if the trouble breaks out again. At the present stage we can only explain how the trouble has been produced without knowing the cause.

COMPARISON OF THE OUDTSHOORN DEFECTS WITH THE ORDINARY SHRINKAGE BAR.

One is naturally inclined to compare this new defect with the ordinary shrinkage bar with which the ostrich farmers everywhere are familiar. In the last number of the *Agricultural Journal* a full account was given of how the shrinkage bar is produced, namely, by the wrinkling of the feather-sheath upon the soft growing feather at the region of the weaker night rings. In the shrinkage bar the defect is always very narrow, being only the width of a night ring, that is, about a sixteenth of an inch; moreover, the shaft and barbs are often indented by the wrinkling, while the barbules are usually present, but not properly separated from the barbs. In this Oudtshoorn trouble the barbules have either not been formed or are very rudimentary, there is no kinking of the barbs and shaft, and the defect is continuous for both the day and night growth, having certainly lasted over a week in the case of the first and second attacks, though shorter in the third. It points to some continuous ailment in the bird as a whole. While primarily the shrinkage bar is due to the differences in blood-pressure, it is only the difference between the day and night periods which has to be taken into account; in this newer defect also we have a diminished blood-pressure to deal with, but it is continuous, irrespective of the day and night changes. The physiological causes of the two defects are therefore altogether different. The one is much rarer and should be easy of remedy if, whenever it appears, an examination is made of the weeds the bird is feeding upon, while the other is more constitutional and dependent upon the general condition of the bird influenced by climatic and other changes.

HOW DENSE HEAVY FLUES ARE PRODUCED.

From Fig. 2 and the facts presented in connection therewith we are now in a better position to understand the physiological conditions under which a dense heavy flue is produced. A feather is very largely dense in proportion to the length of the barbules. Probably more than in any other way the present wave of feather improvement shows itself in an increase in the length of the barbule, though associated with it is an increase in width and length of the flue and a closer arrangement of the barbs on the shaft. In these improved feathers much depends upon the strain of the

* The introduction of the question of the poisonous nature or otherwise of the *Kissie Blaar* (*malva parviflora*) before a recent meeting of the Upper Albany Farmers' Association brought forth expressions of opinion very divergent in their nature, some contending that the plant was perfectly harmless while others were just as convinced by their experience that it was poisonous. As soon as opportunity offers it is hoped to conduct experiments on the subject. It seems not unlikely that different plants may be included under the name *Kissie Blaar*, and in any discussion on the subject it is desirable that specimens of the plant should be forwarded to Dr. S. Schonland, Albany Museum, Grahamstown, who has kindly offered to identify them.

bird, but probably quite as much, and in the opinion of many farmers even more, depends upon the nutritive conditions of the bird. Fig. 2 and its explanation shows how nutrition acts in influencing the feathergrowth. When a bird is in excellent condition from high feeding on lucerne or rape a more copious supply of blood circulates in the pith of the feather, more of the blood plasma exudes through the walls of the blood-vessels and bathes the feather-forming cells; this stimulates them to increased growth and multiplication, which means greater length and strength in all the parts concerned. The barbule-forming cells being furthest from the pith share in this increased nutrition to a greater proportionate degree than the barb-forming cells, hence we get an increased growth in the length of the barbule and the greatly desired density to the feather.

Whatever be the strain of the bird, a high-class plume is not produced unless the nutritive conditions are also favourable. The ostrich is exceedingly sensitive in this respect as regards its feathers, and probably most farmers have been disappointed at times in not getting from superior birds the superior clipping they were known to have produced in the district from which they were purchased. Do what he will and provide himself with the best strains possible, a farmer will not produce the best results unless the nutritive conditions for his birds are highly favourable, and knowing the nature of the parts of the feather we can now more readily understand how this comes about.

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